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Damage Detection in a Cantilever Beam under Different Excitation and Temperature Conditions

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Abstract : Condition monitoring of structures in service is very important as it provides information about the risk of damage development. One of the essential constituents of structural condition monitoring is the damage detection methodology. In the context of condition monitoring of in service structures a damage detection methodology analyses data obtained from the structure while it is in operation. Usually, this means that the data could be affected by operational and environmental conditions in a way that could mask the effects of a possible damage on the data. This, depending on the damage detection methodology, could lead to either false alarms or miss existing damages. In this article a damage detection methodology that is based on the Spatio-temporal continuous wavelet transform (SPT-CWT) analysis of a sequence of experimental time responses of a cantilever beam is proposed. The cantilever is subjected to white and pink noise excitation to simulate different operating conditions. In addition, in order to simulate changing environmental conditions, the cantilever is subjected to heating by a heat gun. The response of the cantilever beam is measured by a high-speed camera. Edges are extracted from the series of images of the beam response captured by the camera. Subsequent processing of the edges gives a series of time responses on 439 points on the beam. This sequence is then analyzed using the SPT-CWT to identify damage. The algorithm proposed was able to clearly identify damage under any condition when the structure was excited by white noise force. In addition, in the case of white noise excitation, the analysis could also reveal the position of the heat gun when it was used to heat the structure. The analysis could identify the different operating conditions i.e. between responses due to white noise excitation and responses due to pink noise excitation. During the pink noise excitation whereas damage and changing temperature were identified it was not possible to clearly identify the effect of damage from that of temperature. The methodology proposed in this article for damage detection enables the separation the damage effect from that due to temperature and excitation on data obtained from measurements of a cantilever beam. This methodology does not require information about the apriori state of the structure.

Keywords : spatiotemporal continuous wavelet transform, damage detection, data normalization, varying temperature
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